

Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY
Bachelor of Engineering - SEMESTER - III EXAMINATION - WINTER 2025

Subject Code: BE03004031

Date: 17-12-2025

Subject Name: Thermodynamic in Biochemical Processes

Time: 10:30 AM TO 01:00 PM

Total Marks: 70

Instructions

- 1. Attempt all questions.**
- 2. Make suitable assumptions wherever necessary.**
- 3. Figures to the right indicate full marks.**
- 4. Simple and non-programmable scientific calculators are allowed.**

	Marks
Q.1 (a) Define the following terms: Internal energy, enthalpy, and entropy	03
(b) Discuss about liquid-liquid equilibrium (LLE).	04
(c) Explain with a schematic diagram the working of an absorption refrigeration system.	07
Q.2 (a) State scope and limitations of thermodynamics.	03
(b) Discuss Rankine cycle with a neat sketch.	04
(c) Derive the mathematical expression for the first law of thermodynamics for flow processes.	07
OR	
(c) Starting from the definition of primary thermodynamics properties, derive Maxwell's equations.	07
Q.3 (a) Define fugacity and fugacity coefficient.	03
(b) Define chemical potential and partial molar properties.	04
(c) Derive the equation for criteria for phase equilibrium in terms of chemical potential for a mixture of N components and π phases.	07
OR	
(a) Discuss the concept of vapour-liquid equilibrium for pure component.	03
(b) Differentiate ideal solutions and non-ideal solutions.	04
(c) Derive Gibbs-Duhem equation.	07
Q.4 (a) Write down the modified Raoult's law explaining each term associated with it and also explain its applicability.	03
(b) Derive from the first principles, $\Delta G^0 = -RT \ln K$.	04

- (c) Consider a system in which following reaction occurs: 07



If there are 2 mole of CH_4 and 3 mole of H_2O present initially, derive the expression for the mole fractions of the components in terms of extent of the reactions.

OR

- (a) Differentiate between aerobic and anaerobic metabolism. 03
- (b) Explain the effect of temperature, pressure and total stoichiometric number on equilibrium constant. 04
- (c) The vapour pressures of acetone (1) and acetonitrile (2) can be evaluated by the Antoine equations: 07

$$\ln P_1^{\text{sat}} = 14.5463 - \frac{2940.46}{T - 35.93} \quad \text{and} \quad \ln P_2^{\text{sat}} = 14.2724 - \frac{2945.47}{T - 49.15}$$

where T in K and p_i^{sat} in kPa. Assuming that the solution formed is ideal, calculate: i) P and y_1 at 327 K and $x_1 = 0.4$, ii) P and x_1 at 327 K and $y_1 = 0.4$, and iii) x_1 and y_1 at 327 K and 65 kPa.

- Q.5** (a) Explain metabolic pathways and give one example. 03
- (b) Explain how yield coefficients are determined for microbial growth and product formation. 04
- (c) Explain the concept of energy coupling in biochemical systems. How do ATP and NADH participate in coupling exergonic and endergonic reactions? 07

OR

- (a) Explain the term “energy carrier” and name any three biological energy carriers. 03
- (b) Explain the concept of thermodynamic efficiency of biological systems with an example. 04
- (c) Discuss the thermodynamics of microbial growth including maintenance energy and efficiency. 07
